

INDIANA STATE BOARD OF HEALTH
DIVISION OF WATER POLLUTION CONTROL

CLARKSVILLE(N) CLARK COUNTY

WASTELOAD ALLOCATION

A SIMPLIFIED STEADY STATE MODEL

FINAL

MARCH 1983

A. WATERWAY DESCRIPTION

This wasteload allocation is a re-evaluation of a previous study done in September of 1981 and applies to only the north plant.

Silver Creek is a small stream in Clark County which flows south past the Town of Clarksville to the Ohio River. At the Clarksville North Sewage Treatment Plant which discharges to Silver Creek, the drainage area is approximately 220 square miles, as calculated from the USGS gage station located 8 miles upstream at Sellersburg. The distance from the Clarksville North Plant to the Ohio River is 4 miles. According to USGS (telephone conversation), the updated calculation of the G7,10 values at the Clarksville plant are 0.3 cfs for summer and 0.0 cfs for annual. The downstream slope for the first two miles is approximately 5 feet per mile as measured by USGS. Telephone conversations with the STP operator revealed that during low flow, the stream is approximately 35 feet wide and 9 inches deep with a fairly uniform depth, and that it has long pooled areas. Upstream 1/2 mile is a dam of 70 feet in width over which all water passes. Land use surrounding the stream is woodland, farmland, and residential. A map (Figure 3) showing the stream and Town locations is attached. The Habitat Evaluation is contained in Appendix A and gives a more detailed description of the stream. The report recommends a general use designation.

B. MUNICIPAL WASTEWATER FACILITY

Currently the North Plant is a Class II, 0.9 mgd (1.4 cfs) activated sludge treatment plant with effluent chlorination. Table 4 is an operation summary of effluent data for 1982. According to consulting engineers the evaluation of a 1.75 mgd (2.71 cfs) flow is needed.

C. APPLICABLE WATER QUALITY STANDARDS

This stream is included in Indiana's regulation 330 IAC 1-1. The stream water quality standard established by this regulation for dissolved oxygen is an average concentration of at least 5.0 mg/l and a minimum of 4.0 mg/l. The Indiana recommendation for an un-ionized ammonia instream concentration of 0.033 mg/l monthly average and 0.05 mg/l weekly average were used for the effluent ammonia limitation.

D. MODEL_PARAMETER_ESTIMATION

Since the dry weather flow for this stream is 0.3 cfs, stream flow plus the effluent flow of 2.71 cfs would result in a total stream flow of 3.01 cfs.

The velocity and depth were calculated using data collected by USGS in surveys conducted in 1977 and 1978. Slope data was also collected during this period.

The resultant K2 selected of 7.08 day⁻¹ at 20 degrees Centigrade is based upon the O'Conner formula and represents a reasonable value for this stream system. Other calculations appear outside the expected range of values: Langbein 1.77, Tsivoglou 1.71 for this slope and stream character. CBOD, NBOD, and benthic deoxygenation rates as recommended by EPA were used. They are 0.4, 0.4, and 0.35 respectively.

Temperature selected was 25 degrees C. and pH selected was 7.5 su.

The conversion factor for CBODu to effluent monthly average CBOD5 was 2.3. NODu was converted to effluent monthly average Total ammonia-N by dividing by 4.57.

Documentation of these values is presented in Table 1.

E. SENSITIVITY ANALYSIS OF INPUT VARIABLES

The sensitivity analysis is presented in Figures 1 and 2. As seen in Figure 1 pH most greatly affects ammonia concentration. However, nitrification of the effluent is required for the entire range of values calculated. Since there is little headwater flow, toxicity of ammonia is a critical consideration.

The sensitivity of effluent CBODu to the variation of reaction rate coefficients one at a time is shown in Figure 2. K2 variation has the largest impact with treatment ranging from secondary to AWT.

Table 3 shows the effect of alternative levels of treatment on the water quality of the stream. One stage nitrification of the effluent appears to be the alternative which best meets the stream water quality standards.

F. RECOMMENDED EFFLUENT LIMITATIONS

The effluent limits recommended by this analysis are presented in Table 2. The computer analysis outputs are shown in Appendix B. The summer limits for CBOD5/Total Ammonia-N/D.O. are 20/2/6. The winter limits for CBOD5 /Total Ammonia-N/D.O. are 20/4/5. average.

Since ammonia toxicity is critical in this low headwater flow stream system, its removal is necessary regardless of the design flow of the plant. The effluent limitations presented are applicable to the flow range of 0.9 to 1.75 mgd inclusive.

TABLE 1 DOCUMENTATION FOR INPUT VARIABLES SELECTION FOR WASTELOAD ALLOCATION ANALYSIS

SEWAGE TREATMENT PLANT CLARKSVILLE (N)
 COUNTY CLARK
 RECEIVING STREAM SILVER CREEK MAIN STREAM OHIO RIVER

This table being re-written & typed.

INPUT VARIABLES VALUE MEASURED VALUE SOURCE

RECEIVING STREAM FLOW DATA

[A] STREAM FLOW (Q7,10) 0.30 USGS STATION LOCATED AT SELLERSBURG

[B] HEADWATER QUALITY

[1] TEMPERATURE	25.00	CG		
[2] DISSOLVED OXYGEN	7.54	MG/L		SEE TEXT FOR THE SELECTION OF INPUT VALUES FOR SENSITIVITY ANALYSIS. VALUES WERE VARIED OVER A WIDE RANGE
[3] pH	7.50	SU		
[4] AMMONIA-N (NOD)	0.45	MG/L		
[5] BODU	6.00	MG/L		

[C] STREAM SLOPE 5.00 FT/MI SLOPE DETERMINED BY USGS

[D] TIME OF TRAVEL 0.300 MI/HR
 VELOCITY D/S OF STP 0.190 FT/SEC 0.44 FT/SEC AT 24.00 CFS DATA COLLECTED BY USGS IN 1977 AND 1978
 $V2=V1(Q2/Q1)^{0.4}$

[E] DEPTH D/S OF STP 0.860 FT 0.00 FT AT 24.00 CFS
 $D2=D1(Q2/Q1)^{0.6}$

[F] REACTION RATES RANGE FOR SENSITIVITY ANALYSIS USEPA RECOMMENDED METHOD WAS USED WITH VARIOUS K2 - OPTION

BOD K1 [1/DAY]	0.400	0.40 AVE IN REACH	0.20 TO 0.60	
NBOD K3 [1/DAY]	0.400	0.40 AVE IN REACH	0.20 TO 0.60	
BENTHIC Kb [1/DAY]	0.350	0.35 AVE IN REACH	0.20 TO 0.50	
REAERATION K2 [1/DAY]	7.080	7.08 AVE IN REACH	3.50 TO 10.00	O'CONNER

[G] SEWAGE TREATMENT PLANT

DESIGN FLOW (YEAR 2000) 1.750 MGD 2.71 CFS CONSULTANT ENGINEER
 DISSOLVED OXYGEN 6.000 MG/L RANGE 0.00 TO 0.00 SELECTED VALUE



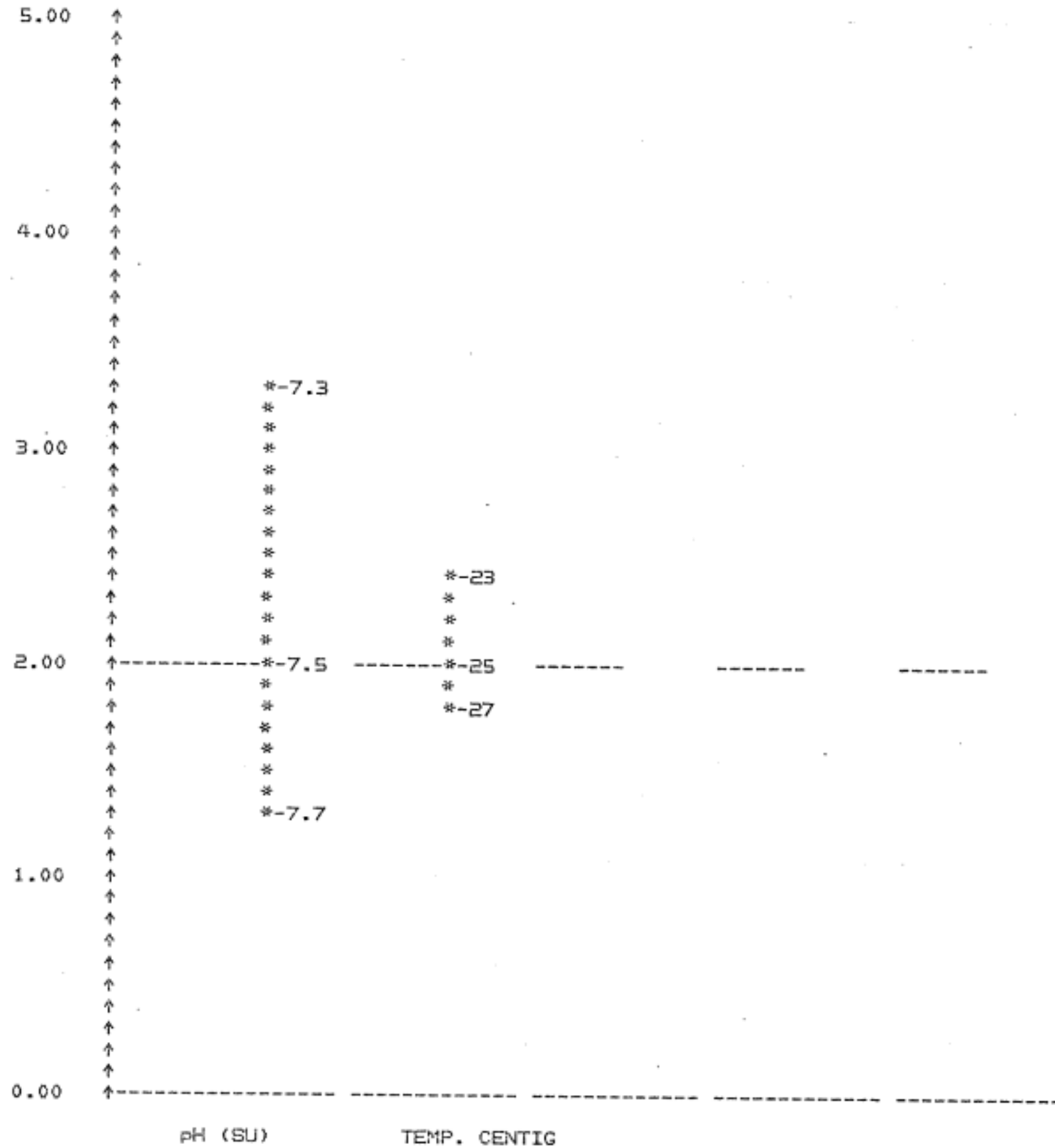
Figure 3

92-500-3

92-500-A

92-500-4

Y - AXIS REPRESENTS EFFLUENT AMMONIA-N VARIATION MG/L WRT TO TEMPERATURE AND pH



INSTREAM AMMONIA TOXIC LIMIT = 1.88 MG/L

CORRESPONDING EFFLUENT AMMONIA LIMITATION = 2.0 MG/L

Figure 2
Sensitivity of $CBOD_u$ to K rate
Clarksville North - Silver Creek

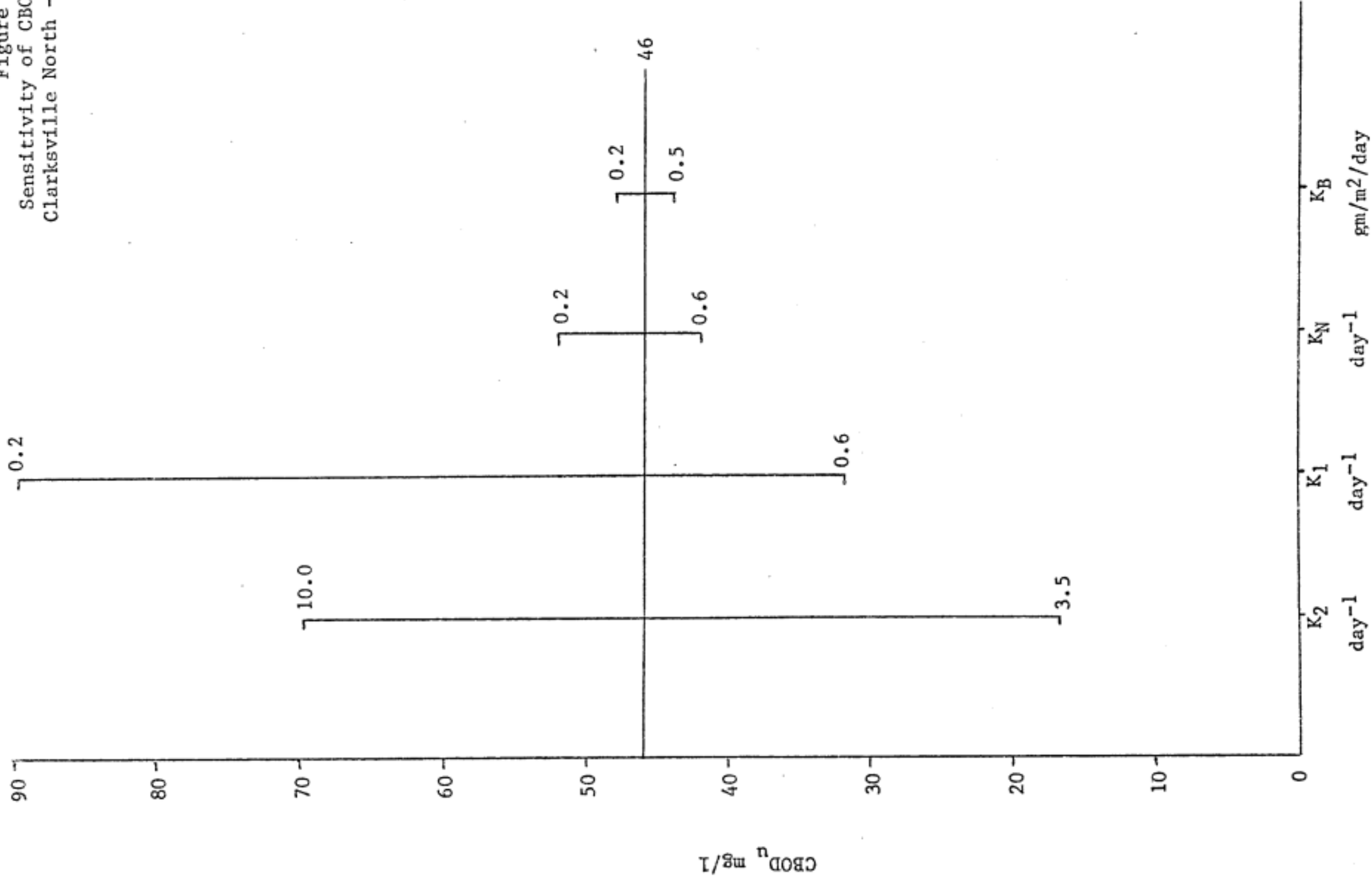


TABLE 2

SUMMER WASTELOAD ALLOCATION ANALYSIS

SEWAGE TREATMENT PLANT
RECEIVING STREAM (S)CLARKSVILLE (N)
SILVER CREEKCOUNTY
MAINCLARK
OHIO RIVER

RECOMMENDED EFFLUENT LIMITATIONS

	SUMMER				WINTER			
	[MAY THROUGH NOVEMBER]				[DECEMBER THROUGH APRIL]			
	WEEKLY		MONTHLY		WEEKLY		MONTHLY	
DESIGN EFFLUENT FLOW	1.750	MGD	1.750	MGD	1.750	MGD	1.750	MGD
CBOD5	30.000	MG/L	20.000	MG/L	30.000	MG/L	20.000	MG/L
AMMONIA - N	3.000	MG/L	2.000	MG/L	6.000	MG/L	4.000	MG/L
DISSOLVED OXYGEN	6.000 MG/L		DAILY		5.000 MG/L		DAILY	

TABLE 3

TESTING OF ALTERNATIVE TREATMENT LEVELS FOR SUMMER WASTELOAD ALLOCATION ANALYSIS

SEWAGE TREATMENT PLANT RECEIVING STREAM (S)	CLARKSVILLE (N) SILVER CREEK		COUNTY MAIN	CLARK OHIO RIVER	SIMULATED INSTREAM WATER QUALITY FOR A SELECTED ALTERNATIVE						
	Ult. cBOD MG/L MONTHLY	NH ₃ -N [NOD] MG/L MONTHLY			MONTHLY						
SECONDARY EFFLUENT LIMITS	50	54									
Single Stage NITRIFICATION	46	9	[12 Monthly]	MAX AMMONIA	2.66	DOSAG	2.28	MG/L	OCCURS AT	0.990	MILES
Two Stage NITRIFICATION	35	6.75	[2 Monthly]	MAX AMMONIA	2.00	DOSAG	5.08	MG/L	OCCURS AT	0.840	MILES
Rapid Sand FILTER	21	54	[1.5 Monthly]	MAX AMMONIA	1.50	DOSAG	5.70	MG/L	OCCURS AT	0.680	MILES
			[12 Monthly]	MAX AMMONIA	2.66	DOSAG	3.64	MG/L	OCCURS AT	0.930	MILES
RECOMMENDED EFFLUENT LIMITS	46	9		MAX AMMONIA	2.00	DOSAG	5.08	MG/L	OCCURS AT	0.840	MILES
LOW HEADWATER DILUTION- AMMONIA REMOVAL REQUIRED											

TABLE 4
 CLARKSVILLE NORTH
 1982 EFFLUENT DATA

MONTH	FLOW MGD	BOD5 MG/L	SS MG/L	NH3-N MG/L
JANUARY	0.766	84.0	57.0	12.7
FEBRUARY	0.785	81.0	39.0	12.5
MARCH	0.887	53.0	32.0	18.8
APRIL	0.997	56.0	53.0	10.8
MAY	0.869	133.0	118.0	22.1
JUNE	0.972	69.0	65.0	12.9
JULY	0.862	121.0	170.0	16.6
AUGUST	0.790	58.0	66.0	14.2
SEPTEMBER	0.868	123.0	122.0	14.9
OCTOBER	0.709	43.0	34.0	13.3
NOVEMBER	0.770	0.0	50.0	13.3
DECEMBER	0.960	76.0	65.0	12.2
AVERAGE	0.853	82.0	73.0	14.5

Environmental Evaluation

Clarksville No. 2 STP
Silver Creek
9/29/81

This evaluation applies to Silver Creek from Blackston Mill Park Dam downstream to its confluence with the Ohio River.

The main vegetation of the watershed is forest and field crops. The major land use is agriculture and urban dwelling space. The average width of Silver Creek is about 30 feet and the average depth is about one foot. There are a few areas where the water deepens slightly and shallow pools are formed. There are no true riffles. The stream bed in this area has very little grade and the flow was estimated at 0.1 fps. The stream bed is bedrock with a slight layer of silt and mud. The stream banks are extremely steep and are made up of rock ledges.

The Clarksville STP was discharging a low quality effluent at the time of the evaluation. The effluent was turbid with suspended solids, there were large quantities of suds and scum, and a strong sewage odor. However, this degradation was evident for only a few feet downstream of the outfall, from there on there was no visible pollution.

Several species of minnows and larger fish were observed both upstream and downstream of the STP discharge. Hogsuckers and small sunfish were numerous. Because of the low flow, the fish habitat in general was poor; however, a limited sport fishery existed at the time of the evaluation. Downstream toward the Ohio River confluence a true sport fishery exists because stream depth increases.

The stream bedrock made poor habitat for macroinvertebrates, however, small populations of mayfly and caddis larvae were found.

Silver Creek, both upstream and downstream of the Clarksville STP, is a high use stream. There are parks along this stretch and aesthetically pleasing areas that are used for hiking and nature study. It is evident that a lot of wading is done, but swimming and canoeing is prevented by the low flow and lack of depth.

This is an unusual situation where Silver Creek in this area is definitely a general use stream, yet AWT would only enhance, not increase stream uses. The limiting factor is lack of flow and depth. There is a dam at Blackston Mill Park upstream of the Clarksville STP discharge.

SEWAGE TREATMENT PLANT = CLARKSVILLE (N) SUMMER WASTELOAD ALLOCATION ANALYSIS BASED ON USEPA SIMPLIFIED MODEL DATE = MAR 1983
 COUNTY = CLARK RECEIVING STREAM = SILVER CREEK MAIN STREAM = OHIO RIVER SIMULATED BY = GED

GENERAL USE STREAM DESIGNATION RECOMMENDED BY HABITAT EVALUATION LOW HEADWATER STREAM- AMMONIA REMOVAL REQUIRED.

STREAM WATER QUALITY STANDARDS

DISSOLVED OXYGEN = 5.00 MG/L UN-IONIZED AMMONIA IN MG/L = 0.050 [WEEKLY] 0.033 [MONTHLY]

HEADWATER AND EFFLUENT WATER QUALITY INPUT DATA REACH NUMBER 1

	FLOW CFS	BOD (ULTIMATE) MG/L	NBOD MG/L	DISSOLVED OXYGEN MG/L	TEMPERATURE CG
HEADWATER WATER QUALITY	0.30	6.000	0.457	7.540	25.00
EFFLUENT WATER QUALITY	2.71	46.000	9.000	6.000	25.00
STREAM WQ D/S OF STP	3.01	42.013	8.148	6.153	25.00

HYDRAULIC CHARACTERISTICS OF STREAM BELOW TREATMENT PLANT OR JUNCTION

VELOCITY IN FT/SEC = 0.190 HYDRAULIC DEPTH IN FT = 0.8600 STREAM BED SLOPE IN FT/MILE = 5.00 MANNING'S COEFF = 0.150
 REACH SILVER CREEK MILES FROM 3.000 TO 0.000 COMPUTATIONAL ELEMENT 0.25000 MILE

REACTION AND REGENERATION RATES

		AT 20 CG	AT INSTREAM TEMP 25.00 CG	REMARK
REAERATION RATE	[1/DAY]	7.08327	7.97505	BY O'CONNER'S EQUATION
BOD DECAY RATE	[1/DAY]	0.40000	0.50326	
NBOD DECAY RATE	[1/DAY]	0.40000	0.64420	
SEDIMENTATION RATE	[1/DAY]	0.00000	0.00000	"- "SUSPENSION "+" SEDIMENTATION
SEDIMENT (BENTHIC) OXYGEN DEMAND		0.35000	0.47953	IN GM/SQ.M/DAY AT 20 CG

SIMULATED INSTREAM WATER QUALITY DOWNSTREAM OF A DISCHARGER OR BELOW JUNCTION

TIME DAYS	DISTANCE BELOW REACH MILE	DISCHARGER FROM OUTFALL	DISSOLVED OXYGEN MG/L	BOD (ULTIMATE) MG/L	NBOD MG/L
0.00	MILE = 3.00	MILE = 0.00	6.153	42.013	8.148
0.08	MILE = 2.75	MILE = 0.25	5.474	40.347	7.737
0.16	MILE = 2.50	MILE = 0.50	5.180	38.746	7.346
0.24	MILE = 2.25	MILE = 0.75	5.086	37.210	6.975
0.32	MILE = 2.00	MILE = 1.00	5.096	35.734	6.623
0.40	MILE = 1.75	MILE = 1.25	5.157	34.317	6.289
0.48	MILE = 1.50	MILE = 1.50	5.243	32.956	5.971
0.56	MILE = 1.25	MILE = 1.75	5.340	31.649	5.670
0.64	MILE = 1.00	MILE = 2.00	5.440	30.394	5.384
0.72	MILE = 0.75	MILE = 2.25	5.541	29.188	5.112
0.80	MILE = 0.50	MILE = 2.50	5.639	28.031	4.854
0.88	MILE = 0.25	MILE = 2.75	5.734	26.919	4.609
0.96	MILE = 0.00	MILE = 3.00	5.825	25.851	4.376

MINIMUM DISSOLVED OXYGEN 5.08 MG/L OCCURS AT 0.270 DAY AND 0.8394 MILES
BELOW DISCHARGER OR JUNCTION

SEWAGE TREATMENT PLANT = CLARKSVILLE (N) WINTER WASTELOAD ALLOCATION ANALYSIS BASED ON USEPA SIMPLIFIED MODEL DATE = MAR 1983

COUNTY = CLARK RECEIVING STREAM = SILVER CREEK MAIN STREAM = OHIO RIVER SIMULATED BY = GED

GENERAL USE STREAM DESIGNATION RECOMMENDED BY HABITAT EVALUATION LOW HEADWATER STREAM- AMMONIA REMOVAL REQUIRED.

STREAM WATER QUALITY STANDARDS

DISSOLVED OXYGEN = 5.00 MG/L UN-IONIZED AMMONIA IN MG/L = 0.050 [WEEKLY] 0.033 [MONTHLY]

HEADWATER AND EFFLUENT WATER QUALITY INPUT DATA REACH NUMBER 1

	FLOW CFS	BOD (ULTIMATE) MG/L	NBOD MG/L	DISSOLVED OXYGEN MG/L	TEMPERATURE CG
HEADWATER WATER QUALITY	0.00	0.000	0.000	0.000	0.00
EFFLUENT WATER QUALITY	2.71	46.000	18.280	5.000	15.50
STREAM WQ D/S OF STP	2.71	46.000	18.280	5.000	15.50

HYDRAULIC CHARACTERISTICS OF STREAM BELOW TREATMENT PLANT OR JUNCTION

VELOCITY IN FT/SEC = 0.180 HYDRAULIC DEPTH IN FT = 0.8000 STREAM BED SLOPE IN FT/MILE = 5.00 MANNING'S COEFF = 0.150

REACH SILVER CREEK MILES FROM 3.000 TO 0.000 COMPUTATIONAL ELEMENT 0.25000 MILE

REACTION AND REGENERATION RATES

		AT 20 CG	AT INSTREAM TEMP 15.50 CG	REMARK
REAERATION RATE	[1/DAY]	7.68433	6.90647	BY O'CONNER'S EQUATION
BOD DECAY RATE	[1/DAY]	0.40000	0.32531	
NBOD DECAY RATE	[1/DAY]	0.40000	0.26049	
SEDIMENTATION RATE	[1/DAY]	0.00000	0.00000	"-"SUSPENSION "+" SEDIMENTATION
SEDIMENT (BENTHIC) OXYGEN DEMAND		0.35000	0.26362	IN GM/SQ.M/DAY AT 20 CG

SIMULATED INSTREAM WATER QUALITY DOWNSTREAM OF A DISCHARGER OR BELOW JUNCTION

TIME DAYS	DISTANCE BELOW REACH MILE	DISCHARGER FROM OUTFALL	DISSOLVED OXYGEN MG/L	BOD (ULTIMATE) MG/L	NBOD MG/L
0.00	MILE = 3.00	MILE = 0.00	5.000	46.000	18.280
0.08	MILE = 2.75	MILE = 0.25	5.867	44.747	17.880
0.16	MILE = 2.50	MILE = 0.50	6.382	43.528	17.489
0.25	MILE = 2.25	MILE = 0.75	6.700	42.343	17.106
0.33	MILE = 2.00	MILE = 1.00	6.908	41.190	16.732
0.42	MILE = 1.75	MILE = 1.25	7.054	40.068	16.366
0.50	MILE = 1.50	MILE = 1.50	7.164	38.977	16.008
0.59	MILE = 1.25	MILE = 1.75	7.254	37.915	15.658
0.67	MILE = 1.00	MILE = 2.00	7.331	36.882	15.316
0.76	MILE = 0.75	MILE = 2.25	7.401	35.878	14.981
0.84	MILE = 0.50	MILE = 2.50	7.466	34.901	14.653
0.93	MILE = 0.25	MILE = 2.75	7.528	33.950	14.333
1.01	MILE = 0.00	MILE = 3.00	7.587	33.026	14.020

MINIMUM DISSOLVED OXYGEN 5.00 MG/L OCCURS AT 0.000 DAY AND 0.0000 MILES
BELOW DISCHARGER OR JUNCTION